Sudbury Neutrino Observatory – PMT Calibration and Detector Operation

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The Sudbury Neutrino Observatory [1,2] (SNO) is a next-generation Čerenkov solar neutrino detector being constructed by a collaboration of ~80 physicists from eleven institutions from Canada, England, and the United States. It is located 2020 *m* below ground near Sudbury, Ontario Canada in an active nickel mine operated by INCO, Ltd. The LBNL designed array of 9456 PMTs, viewing the 1000 *tonne* D_2O target, will detect ~13 charged current (CC) and ~5 neutral current (NC) solar neutrino events per day using the current Standard Solar Model predictions and the recent results the from SuperKamiokande detector. SNO has sensitivity to the total neutrino flux, ν_x, independent of neutrino family (x= e, μ, τ) and to the ν_e flux, separately, by measuring charged and neutral current reactions and neutrino-electron elastic scattering. SNO is well suited to investigating a number of neutrino oscillation hypotheses including MSW (matter enhanced) oscillations and vacuum oscillations. The ratio of NC/CC is an excellent indicator for the presence of neutrino oscillations between active species. In addition SNO's sensitivity to spectra distortions, to day-night effects, and to seasonal variations all provide the SNO with complementary signals for separating the different neutrino oscillation solutions. Despite the NC/CC ratio not being sensitive to neutrino oscillations to sterile species, SNO still has sensitivity to many of the oscillation solutions with the resulting spectra distortions or species regeneration within the earth.

With these construction activities completed early in 1998, the filling of SNO's D_2O and H_2O regions started in the April 1998. The installation of the electronics and data acquisition systems was completed in October 1998.

Initial calibration of the detector was started during the summer of 1998. These calibrations including the charge and photon characteristics of the electronics and timing of the PMT array. LBNL leads the calibration of the geometric and timing effects with its array of blue pulsed LEDs and is actively participating in the energy calibration with the ^{16}N source.

LBNL actively participates in the commissioning of the SNO detector and assists with both routine operation and debugging of the detector and with the normal operations associated with filling the detector and staffing scientific manpower needs on site.

Recently the LBNL group produced an external array of 69 PMTs and PMT housings to be operated outside the main PSUP array to serve both as a long-term monitor of the performance and behavior of detector components in ultrapure water and to assist in the diagnosis of anomalous detector behavior. This array consists of three sleds of PMTs (23 PMTs in each) independently lowered into the outer shielding water region and easily extracted for monitoring detector response during its anticipated 10-year operation.

Footnotes and References

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1. G. Ewan, *et al.*, Sudbury Neutrino Observatory Proposal, SNO 87-12 (1987).

2. D. Cowen, *et al.*, The Sudbury Neutrino Observatory, *to be submitted to NIM*.